

Application of enzymes in compound feeds

W.G. SPRING
M. GADIENT
F. HOFFMANN - LA ROCHE LTD
BASEL
SWITZERLAND

SUMMARY - Several aspects of enzyme applications are presented. Most enzyme products are available in two physical forms, dry powders and water soluble liquids. Powders are expected to be free-flowing, easy to mix and stable, whereas liquids should be non-viscous and stabilized. Also, handling of enzymes in feedmill and aspects related to quality controls are presented and discussed. Finally, the author mentions that two characteristics, common to many enzymes, allergic potential and susceptibility to hydrothermal processes, require attention when handling products in feedmill. In consequence, firstly, protective measures should be used when handling enzymes and dust formation avoid. Secondly, where significant losses occur during pelleting and expansion, enzymes may be applied in liquid forma post-pelleting.

Key words: Enzymes applications, feed mill, handling, pelleting process.

RESUME - "Applications des enzymes dans les aliments composés". Cet article présente plusieurs aspects des applications des enzymes. La plupart des produits à base d'enzymes sont disponibles sous deux formes physiques, des poudres sèches et des liquides solubles dans l'eau. Les poudres devraient s'écouler aisément, être faciles à mélanger et stables, tandis que les liquides devraient être non visqueux et stabilisés. De même, la manipulation des enzymes dans les usines d'aliments pour bétail et les aspects liés aux contrôles de qualité sont présentés et discutés. Finalement, l'auteur mentionne que deux caractéristiques, communes à plusieurs enzymes, le potentiel allergique et la sensibilité aux processus hydrothermiques, doivent faire l'objet d'attention lorsque l'on manipule les produits à l'usine de fabrication. Par conséquent, en premier lieu, des mesures de protection devraient être appliquées lors de la manipulation des enzymes ; il faudrait aussi éviter la formation de poussière. En deuxième lieu, là où des pertes significatives ont lieu pendant la granulation et l'expansion, des enzymes devraient être utilisées sous forme liquide en post-granulation.

Mots-clés : Applications des enzymes, fabrique d'aliments pour bétail, manipulation, processus de granulation.

Introduction

Supplemental enzymes are today accepted products to enhance the nutritional value of many feeds for poultry and pigs. In the European feed and premix industry a number of products, such as carbohydrases and phytase, have already an established place in the feed formula. It can be expected that the use of enzymes will become even more widespread in the future and that also additional types of enzymes will be used.

Enzymes are considered as feed additives and are handled as such by the feed industry. A few elements deserve particular attention in order to do so in a safe and efficient way.

Physical form of enzyme products

Animal studies have shown that a number of enzymes are effective in animals. Present commercial enzyme products usually contain several enzyme activities as well as auxiliary materials, such as coating substances, carriers, stabilizers and anti-dusting agents. The range of enzyme activities contained defines the purpose of its use (Table 1).

Most enzyme products are available in two physical forms, dry powders and water soluble liquids. Powders are expected to be free-flowing, easy to mix and stable, whereas liquids should be non-viscous and stabilized.

Table 1 Enzyme activities and their purpose of use

Enzyme activity	Purpose of use
Carbohydrases	
- β -glucanase	Barley-, oats-based diets - for poultry and pigs
- xylanase	Wheat-, rye-based diets - for poultry and pigs
- α -D-Galactosidase	Soybean-rich diets - for poultry and pigs
Phytases	Cereal-, maize-rich diets - for all monogastric animals
Proteases	Protein-rich diets - for poultry, pigs and aquaculture

The dosages of enzyme products to feed vary from 0.03-1.0 kg/t, according to the concentration of enzyme activity.

Handling of enzymes in the feedmill

Like other dry feed additives, enzymes are normally added to premixes, mixed together with the other components of a feed and further processed, by e.g. pelleting.

Two characteristics common to many enzymes - allergic potential and susceptibility to hydrothermal processes - require attention during handling in the feedmill.

Allergic reactions to enzymes (mostly proteases) have been reported from the detergent industry. From there, the feed industry can learn that with correct handling procedures, enzymes can be used safely. Essentially, dust formation and inhalation should be avoided by careful handling, possibly with exhaust ventilation at exposed locations. Protective measures, such as dust masks and gloves, are also recommended for the personnel. A comprehensive system of safety measures, is given by Concoby (1995).

Enzymes are susceptible to hydrothermal treatments as applied in pelleting, expansion and extrusion. It appears that each enzyme product has a specific 'stability curve' and a critical temperature point at which enzyme losses start to accelerate. This is illustrated on the example of a carbohydrase produced by *Trichoderma* (ROXAZYME® G). The enzyme was either added in dry form to mash feed (based on wheat/barley) and pelleted at different temperatures or added as liquid post-pelleting. Enzyme (xylanase) activities were analyzed after the treatments. The result was that a close relationship between enzyme content and pelleting temperature was found (Fig. 1) (Gadient *et al.*, 1993). The same pattern was reflected in animal performance, expressed as feed conversion and weight gain.

For the tested enzyme activity the critical temperature point was around 80°C. This may be of practical concern for some poultry feeds which are conditioned or pelleted at temperatures of 85°C and higher. For other enzymes the situation may be different, since e.g. a critical point of 65°C has been reported for phytase and α -Galactosidase derived from *Aspergillus*.

The main reason for these differences appears to be the enzymes specific protein structure. In addition, there is also only a limited potential to improve stability by product formulation.

When enzymes are used at temperatures beyond the critical point, post-pelleting use of enzymes in liquid form may be considered. Controlled tests and practical experience have shown that post-pelleting application is an efficient way to use enzymes. Losses of below 10% and a precision reaching a CV (coefficient of variation) of less than 10% can be expected. A high precision of enzyme dosage is important as variations from the target dosage may have a direct effect on its efficacy in animals (Fig. 2) (Gadient, 1994).

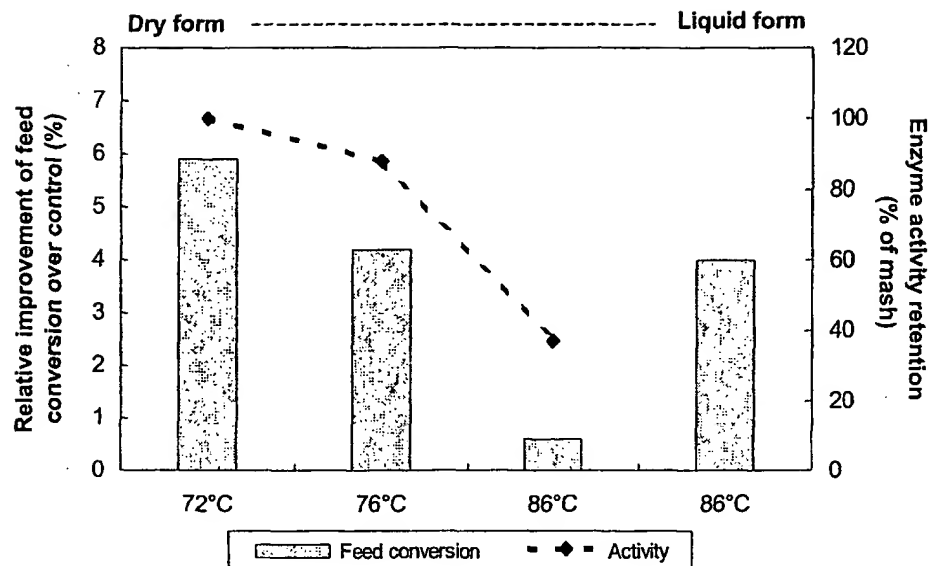


Fig. 1. Enzyme stability and broiler performance, depending on pelleting temperature of feed and form of carbohydrazide.

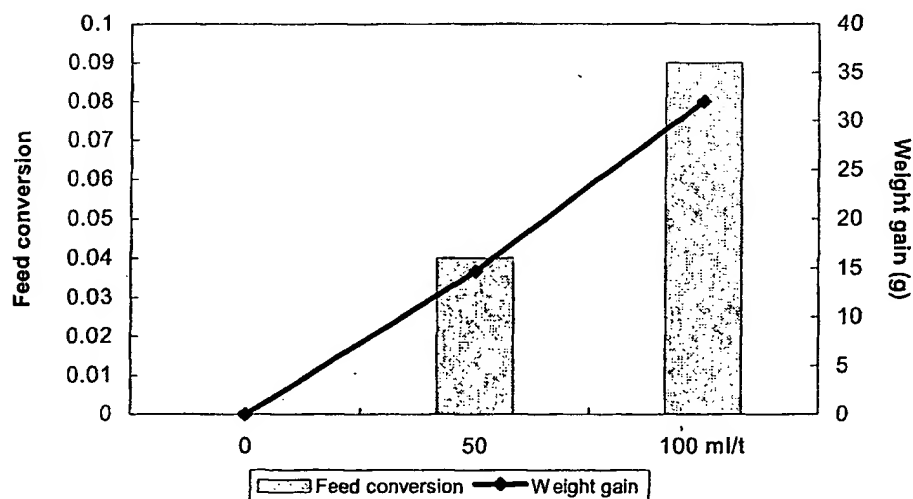


Fig. 2. Improvement (over control) of feed conversion and weight gain of broilers fed feed with ROXAZYME® G2 Liquid, depending on dose rate.

To reach such values, new technology needs to be installed and handled properly. Several key points, as given in Table 2, have to be taken into account.

First, a proportioning system must be available to accurately measure the flow of feed. Secondly, the site of enzyme addition should be well chosen, e.g. the fat addition, conveyors or a place before packing. Finally, an application system must be installed which works with proven precision. There

are several systems available which are able to precisely spray enzyme products with or without prior dilution with water.

Table 2. Key points for successful use of liquid enzymes

Proportioning system

- Gravimetric or impact plate (possibly volumetric)

Site

- After sieving of feed
- With fat addition (keep away from acids and fat temperature above 65°C)
- Conveyors
- Specific spraying unit

Application system

- Spray dilution (1 l, kg/t)
- Dilute and spray
- Spray the enzyme concentrate 'straight' (0.1 l, kg/t)

As an example of post-pelleting application, ROXAZYME® G2 Liquid was applied with the spraying system 'Rotospray' (Gadiant, 1994). The product was dosed either straight at 100, 150 and 200 ml/t or 1:10 diluted with water onto a feed stream of 7 t per hour. The enzyme (glucanase) activity was analyzed after spraying. The results (Table 3) indicate that the enzyme recovery after treatment was good even with addition rates as low as 100 ml/t. The CV values found indicate that the precision of enzyme addition was good. However, the diluted enzymes showed some better results.

Table 3. Recovery of sprayed-on ROXAZYME® G2 Liquid activity in a broiler feed, depending on dosage and application route

Dosage (ml/t of feed)	Application route	Enzyme recovery (% of target) average ¹ CV	
100	straight	126	13%
150	straight	103	13%
200	straight	100	13%
1000	diluted	136	5%
1500	diluted	125	7%
2000	diluted	104	9%

¹N=6

Quality control of enzymes in the feedmill

Ideally, simple quality control procedures should be available to control contents of the various supplemented enzymes in feed or premixes. Yet, this wish does not appear to be realistic. As with other additives, analytical procedures in premixes and feeds are complicated. The reason is that each enzyme activity requires a distinct analytical procedure.

What also obscures the control of enzymes is the fact that internationally standardized activity units do not exist for enzymes. This means that activity units of one product cannot be compared with those of others. This does not makes quality control of enzyme products transparent to users and

authorities. It has also discouraged users to install an in-house analytical control of enzyme content of their feeds.

It can be expected that with a more widespread and established use of enzymes a clearer situation will become established. Till this will happen, the user of enzymes is recommended to: (i) refer for orientation to the services offered by institutes or enzyme suppliers; (ii) run own comparative studies with animals; (iii) use enzyme products with a wide range of enzyme activities (multi-purpose enzymes); (iv) remember that low-cost solutions mostly have the lowest benefits.

Conclusions

Various enzymes products with distinct, standardized activities are available today for use in animals. Respective commercial products have a standardized, stable enzyme content and are available as easy-to-use dry powders or liquids.

Two characteristics common to many enzymes - allergic potential and susceptibility to hydrothermal processes - require attention when handling the products in the feedmill. Firstly, protective measures should be used when handling enzymes, and dust formation avoided. Secondly, where significant losses occur during pelleting and expansion, enzymes may be applied in liquid form post-pelleting.

For most enzyme activities, internationally standardized activity units do not exist and universal assay methods are not available. This makes quality control of enzyme products difficult. For orientation, the user of enzymes may refer to the services offered by institutes or enzyme suppliers and run own comparative studies, e.g. with animals.

References

- Concoby, C. (1995). Proc. of ESFE2, Noordwijkerhout, Netherlands: 256-259.
- Gadient, M., Völker, L. and Schüep, W. (1993). Schriftreihe aus dem Institut für Nutztierwissenschaften, ETH-Zürich, 11: 255-262.
- Gadient, M. (1994). Use of liquid carbohydrases and other additives for animals. *Proc. 3rd Int. Kahl Symp.*, Hamburg, November 29th.